BULLETIN 675 MARCH, 1948

Crossbreeding for the Production of Market Hogs

W. L. Robison

Crossbred pigs at 116 days of age. Poland China by Berkshire-Duroc

OHIO
AGRICULTURAL EXPERIMENT STATION
Wooster, Ohio

The Ohio State University
3 6267 01197429 5

CONTENTS

CROSSBREEDING FOR THE PRODUCTION OF MARKET HOGS

W. L. ROBISON

INTRODUCTION

Crossing Defined

Crossbreeding is not a new procedure. It is practiced with plants and with other animals as well as with hogs. It is the mating of individuals of dissimilar type or breeding. In producing crossbred hogs for market a common practice has been to mate purebred or high grade dams of one breed to a purebred sire of a different breed.

Objectives of Crossing

An object of crossing is to increase the vigor of the offspring. In hogs an increase in vigor can be manifested in more pigs farrowed and saved per litter, in faster gains, and in greater gains per unit of feed consumed. Another, although doubtless less frequent object, is to secure animals that are better adapted for some particular purpose. For example, if the brood sows in a herd are such that when mated to a sire of the same breed they produce pigs that are too rangy or too "chuffy" for prevailing market demands, one might attempt to correct the situation by using a sire of a different breed and type.

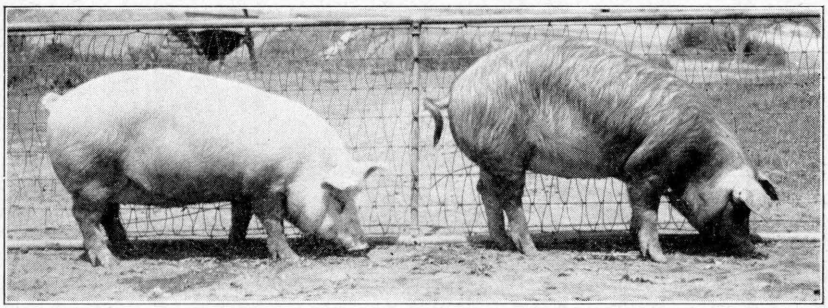

Fig. 1.—Crossbred O. I. C. × Duroc, left; purebred Duroc, right; 1933. Note difference in type between a 227-pound O. I. C. × Duroc and a 228.5-pound rangy Duroc.

Does an increase in vigor occur when different breeds of swine are crossed? If so, how can the most benefit, if any, be derived from it? Will the advantages of crossing outweigh the disadvantages? Although some may be predisposed toward purebreds, regardless of the purpose for which the hogs are produced, these questions are of concern both to the producers of hogs for slaughter and to the producers of hogs for breeding.

Breeding Determines Animal's Possibilities

Breeding, feeding, and management all enter into the production of good animals. An animal may receive good feed and care but be incapable of developing as desired, or it may be capable of developing properly but fail because of poor feed and care. An animal's breeding or heredity determines its possibilities. Its feeding and care determine how nearly those possibilities shall be approached.

Fields in which the heredity of swine can be improved are productiveness, vitality, disease resistance, rapidity of gains, efficiency of feed utilization, freedom from defects or weaknesses, and the quality and cut-out value of the carcasses. By productiveness is meant the number of pigs, capable of living, that are farrowed and the ability of the sow to save and nurse them. Opportunities for improvement are provided by the variations which occur in hogs in these and in other respects. A means of improvement is the careful selection of animals for breeding which differ or show variations in the desired directions.

When two animals which differ in a particular characteristic and which are pure for it are mated the characteristic manifested in the offspring is the dominant. The other is the recessive. Mating the offspring together results in some individuals showing one characteristic and some showing the alternative characteristic. Some of those showing the dominant characteristic will breed true for it and some showing it will not. If both members of a pair of determiners for a dominant characteristic—the one from the sire and the one from the dam—are alike, the individual will breed true for the characteristic expressed. If they differ, the individual will not breed true for this particular characteristic. Complete dominance rarely occurs. Those individuals of the second generation which show the recessive characteristic have received both members of the pair of genes or determiners for it—the one from the sire and the one from the dam—and so will breed true for it.

In the selection of animals for breeding, the individuality and performance of the animals themselves and the individuality, performance, and breeding ability of each of their parents and grandparents should be considered. However, the merit of an animal's offspring is the most reliable index of its worth for breeding. Hence, when information on its offspring becomes available this should be the chief criterion as to whether the animal is to be retained in the herd or, more precisely, that portion of the herd which is kept as a source of improved breeding stock.

Until the characteristics desired are obtained, animals which differ in those directions are wanted. When animals possessing the characteristics desired are obtained, the establishment of strains which will breed true for them is necessary if the characteristics are to be transmitted from parents to offspring with a relatively high degree of certainty. Inbreeding increases the chances of the same characteristics being manifested from one generation to the next.

Crossing and Inbreeding Have Opposite Effects

Inbreeding makes more of the two members of the various pairs of genes or determiners alike. If the inbreeding were continued until the members of practically all of the pairs were alike, the individuals of that inbred strain would then be virtually homozygous; that is, they would breed true and would be alike, or nearly so, in every respect.

The more highly animals are inbred the more nearly homozygous they become and the greater is the likelihood that they will transmit the genes or determiners for the characteristics which they themselves show. For this reason, a good inbred animal is preferable for breeding purposes to an animal of equal goodness that is not inbred.

Inbreeding has the following effects (2, 4, 14, 15): (a) During the first few generations of inbreeding there is a reduction in vigor which is evidenced in various ways. (b) The percentage of individuals showing defects increases. (c) Even when they have the same original parents, different inbred lines tend to become unlike each other. (d) In contrast with this, the individuals within a line become more nearly alike in succeeding generations. (e) After a number of generations, the inbred lines become more or less fixed or stable.

If defects or weaknesses appear when inbreeding is practiced, it is not because of the inbreeding itself but because the defects or weaknesses existed in the parent stock as recessives and were unseen except in the few individuals which happened to be homozygous for them. Defects and weaknesses brought to light by inbreeding can be eliminated from the line by discarding as breeding stock the animals showing them.

Improvements brought about by selection and by the elimination of defects can be held as long as matings are kept within the inbred line. Undesirable, as well as desirable, characteristics become fixed by inbreeding. Since the animals show fewer differences and usually the numbers are limited, progress through further selection may be retarded or halted. Further improvements can be made and held by crossing individuals of the inbred line with individuals of another line or strain, preferably inbreds, that are strong in the respects in which the line is weak, repeating selection for the characteristics desired, and again inbreeding to fix those characteristics.

The ultimate in breeding is the development of a pure line or strain, that is a purebred, carrying genes or determiners for only favorable characteristics. Crossing with some other line or strain would then introduce no genes which would have a more favorable effect than would those already present. The line would be vigorous, have no faults or weaknesses, and would breed true. It would be as suitable for the production of market hogs as for the production of hogs for breeding—that is for the transmitting of inheritance. However, characteristics are inherited in groups. Favorable ones are commonly "linked" with unfavorable ones in their inheritance. Whatever genes or determiners are in the same chromosome, whether they are for favorable or unfavorable characteristics, are inherited together. "Crossing over" sometimes occurs. When it does different genes, or determiners of the characteristics, are inherited as a group. Theoretically, since the groupings or "linkages" do sometimes change, combining only favorable genes or a preponderance of favorable genes in one line is not an absolute impossibility. Nevertheless, the chances of bringing about such a combination, even in the distant future, are extremely remote.

If the animals are intended for slaughter rather than for breeding purposes, inbreeding is not desirable, and the crossing of lines or breeds may be advisable. Crossbred animals will be free from those defects and weaknesses which were eliminated from both or all of the lines crossed to produce them. Being more nearly alike genetically, the individuals resulting from crossing

inbred lines will be more nearly uniform than were the individuals in the populations from which the lines originated. Usually the vigor lost on inbreeding is restored on crossing. The percentage is not high, but some crosses of inbreds show an increase in size and vigor over the original stock.

Some authorities suggest that recessives are more apt to be harmful to the individual than are their alternative dominants. A tendency to produce dominant unfavorable variations has been reduced to the minimum by natural selection. On the other hand, a tendency to produce unfavorable recessive variations has persisted because the latter are protected in heterozygous combinations by their dominant favorable allelomorphs. When different lines are crossed there is a chance that the offspring will receive genes favorable in certain ways from one parent and genes favorable in other ways from the other parent. This favorable complementary effect is offered as the probable explanation of the increase in vigor which sometimes occurs when crosses are made.

Inbred lines of swine are being developed by the United States Department of Agriculture Regional Swine Breeding Laboratory, by collaborating and other state experiment stations (3), and by some breeders. The possibilities from crossing inbred lines of swine and from using inbred or line-cross sires on outbred dams are being investigated. But the merits of a breeding program with hogs similar to or adapted from the one used with corn have not yet been definitely established. Nor are many inbreds yet available for use in the production of hogs for slaughter.

An increase in vigor from crossing is not limited to species crosses and to crosses of inbred lines but may also occur in crosses between different breeds or varieties. As a rule, the increase in vigor from crossing varies with the unlikeness of the inheritance of the lines crossed. Since it is associated with heterozygosity, it is greatest in the first generation and tends to disappear in later generations if the individuals of a given cross are mated with each other.

Most purebreds are not highly inbred. Granting the integrity of the breeders and excepting some of the newer breeds, they have been bred for many generations without intermating with animals of other breeds. Presumably, breeds differ considerably in their genetic makeup. If they do, some increase in vigor from crossing non-inbred animals of different breeds would not be surprising. Possibly, although the amount anticipated would be less, outcrossing within a breed—that is mating animals that are of the same breed but that have no common ancestors for a number of generations—will give some increase in vigor. Neither plan would be expected to give as much increase in vigor as crossing highly inbred animals of different lines, particularly if they were of different and dissimilar breeds.

Desirability of Crossing An Unsettled Question

Until a better procedure can be developed, tested, and applied, will anything be gained from crossing non-inbred animals of different breeds in the production of market hogs? Opinions differ as to whether crossbreeding for the production of market hogs is desirable. The disagreement is not limited to breeders and producers but extends to research workers who have carried on crossbreeding investigations or have studied crossbreeding data.

The authors (Winters et al. 11, 12) of Extension Bulletin 180, University of Minnesota, state, "The results obtained from experiments and in farmers' herds made it clear that for market hog production the three types of crossbreds produced possess distinct advantages. It has been proved conclusively that crossbred sows excel as mothers, whether mated to a boar of a third breed or back to one of the breeds that entered in their own breeding. It is very clear that there is as much additional benefit from keeping the crossbred sows for breeding as there is in making the original crosses."

Lush, Shearer, and Culbertson (6), in Iowa Experiment Station Bulletin 380 state, "However, nearly all those who have studied this question have found advantages, not always statistically significant, for the crossbred pigs, and therefore the conclusion seems unescapable that, in general, crossbred pigs tend to be somewhat more vigorous and thrifty than would be expected from the average of the two parent breeds. Because of this added vigor, the crossbreds generally show a lower death rate up to weaning time and, consequently, larger and heavier litters weaned. Also, they generally gain weight a little more rapidly on a little less feed than the purebreds. For the same reason, the crossbred gilts or sows, when used for breeding purposes, can be expected to wean slightly larger and heavier litters than purebreds, but these things should not be expected to happen every time a cross is made any more than slightly loaded dice would be expected to turn up a winning combination every time they were thrown."

Carroll and Roberts (1), in Illinois Experiment Station Bulletin 489, state, "These averages do not support the belief that hybrid vigor can be expected in the majority of crosses between breeds of swine.

What appears from these averages to have occurred is not so suggestive of hybrid vigor as of a grading-up process of the poorer purebreds toward the better purebreds. The averages show only that the crossbreds approach but do not excel the better purebreds. If this is true, crossbreeding has nothing to offer the breeder with a highly improved, carefully selected herd. On the other hand, crossing less productive animals with animals of higher productivity might be expected to yield a crossbred that would excel the poorer parent. But mating poor purebreds with good animals of the same breed would be expected to improve the poor purebreds as much as crossing them with good animals of another breed."

In their studies, the number farrowed, the weight at birth, the number surviving, the weight at weaning, the rapidity of the gains, and the efficiency of feed utilization were considered separately, rather than in their over-all effect.

These summaries are sufficient to show that opinions on the merits or demerits of crossbreeding differ. The lack of agreement emphasizes the need for further carefully planned extensive experiments to provide conclusive evidence as to whether there is a place for crossbreeding in the production of market hogs. If the practice of crossbreeding is to be continued, further data on the effect of size and on the types, breeds, and strains preferable for crossing are needed.

Reciprocal crosses should be made and the crossbreds should be compared with purebreds of the two or more breeds involved in the crosses. Insofar as the other factors can be controlled, the factor of breeding should be the only variable. A similar environment, including care, health considerations, and

rations, should be provided. In the writer's opinion, unless some specific problem which demands otherwise, for example disease resistance, is being studied, a favorable environment should be provided. Animals typical of the better representatives of the breeds or strains involved should be used.

Some ardent supporters of purebreds have opposed crossbreeding experiments. It is the function of the experimentalist to carry on carefully planned experiments and to present the results impartially so that they will provide unbiased and reliable information on unsettled questions. He should not allow his personal opinions, likes, dislikes, or preconceptions to make him partial in setting up or conducting experiments, in assembling and analyzing data, or in interpreting and reporting the results. When a sufficient body of accurate and reliable information is available, the producer can decide for himself what practice is advisable under a particular set of circumstances.

If, for market hog production, the good ones of certain breeds are not as good as the good ones of other breeds, knowing which are superior would enable the producer to choose those breeds rather than the ones that are not so good. Mating a good animal to a poor one of the same or of a different breed, would be expected to bring about an improvement. Unless no good ones are available, poor ones, if they can be detected, should not be used for breeding. But, regardless of whether poor or good animals are used, the pertinent question in crossbreeding is whether more favorable results will be secured by mating a group of females of one breed with males of the same breed than with males no less meritorious, if such are available, of a different breed.

For crossbreeding to be worthwhile, crossbreds need not be superior in every respect to the better of the two breeds crossed. As a hypothetical case, breed A may save 10 pigs per litter, require 420 pounds of feed per 100 pounds of gain, be ready for market in 220 days, and be excellent in killing qualities. Breed B may save six pigs per litter, require 360 pounds of feed per 100 pounds of gain, be ready for market in 170 days, and be only fair in killing qualities. Animals resulting from a crisscross of the two breeds might save nine pigs per litter, require 365 pounds of feed per 100 pounds of gain, be ready for market at 180 days of age, and be good in killing qualities. Such crossbreds would not be superior to the better of the two parent breeds in a single one of the factors considered but would be above the average of the two in all of these respects. Taking all of the factors mentioned into consideration, they would be preferable to animals of either of the two parent breeds.

Possible Plans of Crossing

If crossbred market hogs are produced, a definite plan of crossing rather than no plan or an indefinite one should be followed.

As mentioned earlier, a common plan of producing crossbreds is to mate purebred or high grade sows of one breed to a purebred sire of a different breed. If desired two or more litters may be raised from the sows before they are marketed. Whenever the sows in the herd are to be replaced, they can all be mated to sires of the same breed as themselves and gilts from this crop of pigs can be saved for the next generation of brood sows or, each season, a sufficient number of the better sows in the herd can be mated to a sire of the same breed as themselves and gilts for replacements in the breeding herd can be selected from their litters.

If gilts only are used, a sufficient number to furnish the gilts for the next generation can be mated to a sire of the same breed as themselves and the remainder can be used for the production of crossbred pigs. An alternative is to purchase the gilts or sows as well as the sires. However, in order to safeguard the health of the herd, a one way traffic, insofar as possible, is advisable. A few animals must be purchased. These should be from healthy herds and should be quarantined for a time upon arrival.

Obviously, the plan of using purebred or high grade sows for the production of crossbred pigs has some disadvantages. A plan that necessitates purchasing as few animals as possible is desirable. One that has continuity or that can be applied to the entire herd is preferable to one that must be interrupted from time to time or else necessitates the use of sires of different breeds the same season. There is an advantage in having all of the pigs in the same season of similar breeding. Regardless of whether they are farrowed in the same or different seasons, if crossbreds are more vigorous than purebreds, there is an advantage also in a plan which results in crossbreds only.

The rotation plan of crossbreeding has these advantages. Some consider it complicated. Actually it is simpler than using purebred or high-grade dams. One may start with whatever sows are in the herd. Although they are of mixed breeding, gilts for the subsequent generations of sows are selected from the herd. Sires of one breed are mated to the original sows. When a new generation of sows is saved, sires of another breed are mated to them. Sows of the third generation are mated to sires of a third breed. If a three-breed rotation is used, this completes the cycle. For the next generation, sires of the same breed as were those for the first are used. The procedure is a continuous one. It consists of rotating sires of two or more breeds on successive generations of sows selected from the herd.

In "crisscrossing", sires of two breeds are alternated for the production of each successive generation of pigs. Probably three breeds are preferable to two. Little or no advantage, however, would be anticipated from the rotation of sires of more than three breeds.

Since, if it occurs, the increase in vigor is at a maximum in the first generation and since the pure breeding is introduced through the sires, purebred sires must be used in the plan. In addition to being purebreds, they should also be good individuals. Crossbreeding precludes improving blood lines. Any improvements that are made in the inheritance of breeding stock must be made by the breeders from whom the purebred sires are purchased. If a particular type of market animal at a given weight is desired, sires of this type should be adhered to in each of the breeds chosen. If a similarity of type is due to a similarity in breeding, this might conceivably have a tendency to reduce somewhat the extent of the increase in vigor.

If crossing results in an increase in vigor, the sows in the rotation plan of crossbreeding have the possibility of showing the effects of their increased vigor in producing and nursing their young. Normally pigs are carried by their dams 113 or 114 days and are suckled by them 56 days. Well-doing pigs can be marketed by the time they are 180 days of age, or within 124 days from weaning. The importance of vigorous dams may be seen when it is realized that for over half of the period from the time of conception to the time of marketing, pigs are directly dependent on their dams.

The plans of the experiments herein reported were governed by circumstances and were not free from fault nor were they all-inclusive in scope. Whether certain types, breeds, or strains are preferable for crossing was not determined. Reciprocal crosses were not made, nor were the crossbreds compared with purebreds of all the breeds involved in the crosses. If facilities were available, tests could be set up which would avoid some of the more conspicuous shortcomings of the tests that were made. The findings are presented not in the belief that they provide the final answer but in the hope that they will contribute some helpful information on the question of crossbreeding.

MIAMI COUNTY TESTS[1]

Plan of Management Used

A project in which crossbred pigs were compared with purebred Durocs was started at the Miami County, Ohio, Experiment Farm, in 1936. The management procedure was to select fall gilts each spring and breed them to farrow when they were approximately a year of age. The same sows were retained to farrow again in the spring, when they were approximately a year and a half of age. After their spring or second litters were weaned the sows were marketed. In this way, although the spring litters were usually farrowed in April, early fall pigs, which were well started when it was necessary to place them in their winter quarters, were obtained. Also, a new generation was produced each year.

Plan of Crossbreeding Used

The plan of crossbreeding followed was that of rotating purebred boars of three breeds on successive generations of sows selected from the herd. The original sows were Durocs. Boars of the Poland China, Hampshire, and Duroc breeds were used. Since the first crop of crossbred pigs was farrowed in the spring, three crops of first-cross pigs, rather than two, were produced at the beginning of the project. Two rotations or cycles were completed and a third one was started. At the beginning of the third cycle the pigs out of the sows of mixed breeding were compared with both purebred and first-cross pigs.

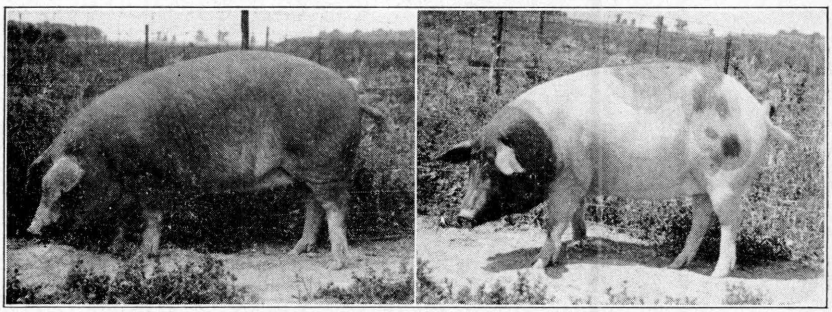

Fig. 2.—Left, purebred Duroc gilt. Right, gilt of mixed breeding produced by rotation system of crossbreeding at the Miami County Experiment Farm.

[1]M. A. Bachtell, in charge of District and County Farms, and P. A. Jones, Superintendent, collaborating.

A repetition of the project with a third group added was planned for starting in 1943. The original sows for all three groups were to be Durocs. The second and the third groups of pigs were both to be produced by rotating sires of the Poland China, Hampshire, and Duroc breeds on successive generations of sows selected from the herd. The two groups were to differ from each other in that the original sows and the sires for the second group were to be outbreds, whereas the original sows and the sires of the third group were to be inbreds. A delay of a year in starting the project was caused by inability to secure inbred Duroc sows. In the meantime, some further comparisons of purebred Duroc and crossbred Poland China × Duroc pigs were made. Since the data for the first generation in the new project were available, the results for the purebred pigs and the crossbred pigs that were from non-inbred parents in it are presented with the data for the original project. Table 1 shows the breeding of the various crops of pigs, together with the results secured.

The weights given in the table are based on ages of 56 and 180 days, respectively. The plan called for taking the weaning weights when the pigs were between 50 and 62 days of age. Sometimes, however, the pigs were more than 62 days of age when they were weighed. The weaning weights were adjusted to the standard age of 56 days by the method suggested by Whatley and Quaife (10). The weights for the 180-day age were determined from the average daily gains to the time of the final weight, which was taken when the pigs were between 174 and 186 days of age.

The spring litters had some advantages over the fall litters. One advantage was that in most instances the dams were a year and a half of age when the spring pigs were farrowed, whereas they were gilts approximately a year of age when the fall litters were farrowed. Another was the season of the year. Pasture was available for the spring pigs throughout the growing and fattening period, whereas it was not for the fall pigs.

Results From Crossing

Twenty-nine Duroc and thirty-three Poland China × Duroc litters were produced in the nine seasons in which they were compared. A summary of the data for the two groups is presented in part A of table 2. A slightly lower percentage of the purebred than of the crossbred pigs survived until they were ready for market. The purebreds gained less rapidly, weighed 22 pounds less per head at 180 days of age, and did not reach an average weight of 220 pounds until 24 days later than the crossbreds.

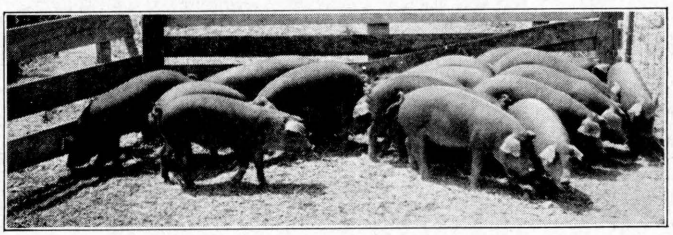

Fig. 3.—Duroc pigs, Miami County Experiment Farm, August 1941.

Seven litters by Hampshire sires and out of Poland China × Duroc dams and an equal number of Duroc litters were produced in the fall of 1937 and spring of 1938, or the two seasons in which they were compared. There was

TABLE 1.—Purebred and crossbred pigs, Miami County Experiment Farm, by seasons

Breeding	Year	Season	Age of sows at farrowing (years)	No. of litters	Pigs per litter at birth		Pigs per litter at weaning	Weight per pig at 56 days	Pigs per litter at 180 days	Daily gain per pig to 180 days	Weight per pig at 180 days	Weight per litter at 180 days
					Live	Dead						
								Lb.		*Lb.*	*Lb.*	*Lb.*
D	1936	S.	1.5	3	9.3	0.0	7.0	31.8	7.0	0.82	148	1036
P x D				3	10.0	0.3	8.3	37.6	8.3	0.93	167	1389
D	1936	F.	1.0	3	10.3	0.7	6.7	27.8	6.3	0.89	160	1016
P x D				5	10.4	0.2	5.4	36.3	5.4	1.07	193	1040
D	1937	S.	1.5	3	9.7	0.3	6.3	34.2	6.3	1.10	198	1247
P x D				4	10.0	0.2	7.5	34.1	7.5	1.13	203	1525
D	1937	F.	1.0	2	8.5	0.5	6.0	29.3	6.0	0.93	167	1003
H x P-D				4	10.5	0.5	7.5	30.0	7.5	0.93	168	1258
D	1938	S.	1.5	5	10.4	0.4	6.6	33.0	6.6	1.16	209	1380
H x P-D				3	9.0	0.3	7.0	35.4	6.7	1.22	219	1460
D	1938	F.	1.0	4	9.0	0.2	7.0	38.1	7.0	0.90	162	1134
D x H-P-D				3	11.3	0.3	10.7	26.3	10.3	0.90	162	1669
D	1939	S.	1.5	3	12.7	0.3	7.0	32.6	6.3	1.05	189	1191
D x H-P-D				3	9.7	0.0	8.3	31.6	7.7	1.10	198	1525
D	1939	F.	1.0	3	9.3	1.0	6.7	32.5	6.7	1.06	191	1278
P x D-H-P-D				4	10.7	1.0	7.5	34.4	7.5	1.13	203	1525
D	1940	S.	1.5	4	12.7	0.5	8.2	36.3	8.2	1.19	214	1748
P x D-H-P-D				1	10.0	1.0	8.0	41.4	8.0	1.28	230	1843
D	1940	F.	1.0	3	11.0	0.3	7.7	32.1	7.0	1.08	194	1361
H x P-D-H-P-D				4	10.5	0.0	9.0	39.0	9.0	1.18	212	1912

TABLE 1.—Purebred and crossbred pigs, Miami County Experiment Farm, by seasons—continued

Breeding	Year	Season	Age of sows at farrowing (years)	No. of litters	Pigs per litter at birth		Pigs per litter at weaning	Weight per pig at 56 days	Pigs per litter at 180 days	Daily gain per pig to 180 days	Weight per pig at 180 days	Weight per litter at 180 days
					Live	Dead						
								Lb.		*Lb.*	*Lb.*	*Lb.*
D	1941	S.	1.5	2	12.5	0.5	9.0	34.4	7.5	1.04	187	1404
H x P-D-H-P-D				3	9.0	0.0	8.3	40.9	8.0	1.19	214	1714
D	1941	F.	1.0	3	9.0	0.0	7.3	.....	7.3	0.96	173	1261
D x H-P-D-H-P-D				4	8.7	0.5	7.5	.....	7.5	1.10	198	1485
D	1942	S.	1.5	3	10.3	1.0	6.7	.....	6.7	1.33	239	1604
D x H-P-D-H-P-D				2	8.0	0.5	7.0	.....	7.0	1.28	230	1613
D	1942	F.	1.0	3	8.3	0.7	5.0	29.7	5.0	0.84	151	756
P x D				3	9.3	0.3	4.3	33.7	4.3	0.97	175	751
P x D-H-P-D-H-P-D				3	8.0	0.7	6.0	35.8	6.0	0.95	171	1026
D	1943	S.	1.5	3	8.7	0.0	5.3	.....	5.3	1.14	205	1088
P x D				3	8.7	0.0	7.0	.....	7.0	1.26	227	1588
P x D-H-P-D-H-P-D				3	10.0	0.7	8.3	.....	8.3	1.34	241	2002
D	1943	F.	1.0	4	8.0	0.2	6.1	26.3	5.7	0.83*	150	861
P x D				4	9.0	0.2	4.7	32.7	4.7	1.11	200	951
D	1944	S.	1.5	4	10.5	0.0	6.5	41.8	6.0	1.14	205	1232
P x D				5	8.4	0.0	6.8	39.5	6.8	1.19	213	1451
D	1944	F.	1.5	3	10.0	0.7	7.3	30.2	7.3	1.04	188	1378
P x D				3	8.3	1.3	8.0	34.6	8.0	1.20	216	1724
D	1945	S.	2.0	3	9.3	1.0	6.3	34.0	6.3	1.09	196	1241
P x D				3	7.7	0.0	5.7	39.1	5.7	1.12	201	1140

D=Duroc. P=Poland China. H=Hampshire.

In the fall of 1941 the pigs suffered from an attack of "flu." No weaning weights were taken then or in the spring of 1943. In the spring of 1942 the weights were taken late and so are omitted.

*Pigs had the "flu" after weaning. Purebreds harder hit than crossbreds.

no difference in the average number of pigs per litter at birth. Owing to heavier losses during the first few days, the purebreds did not average as many pigs per litter at 180 days of age as did the pigs of the three-breed cross.

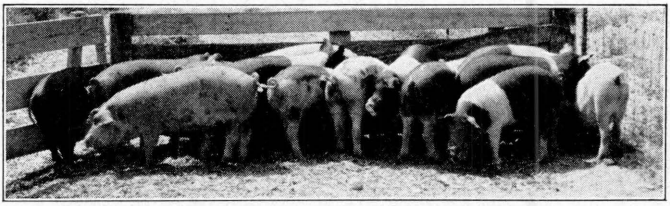

Fig. 4.—Crossbred pigs from rotation system of crossing. Miami County Experiment Farm, August 1941.

In the data presented in part B of table 2, a disparity between the number of fall and spring litters causes the purebreds to appear to have outgained the crossbreds. By referring to table 1, it will be seen that in the fall of 1937 the rapidity of the gains of the purebreds equaled but did not surpass those of the crossbreds. Of the pigs farrowed in the spring of 1938, the crossbreds gained more rapidly than the purebreds.

Part C of table 2 summarizes the performance of the subsequent generations of crossbreds and of the purebred Durocs with which they were compared. The purebred litters contained more pigs at birth. Again, during

TABLE 2.—Crossbred and purebred pigs, Miami County Experiment Farm (A) Two-breed crossbreds. (B) Three-breed crossbreds. (C) Crossbreds of subsequent generations

	A		B		C	
	Durocs	Poland China × Durocs	Durocs	Hampshire × Poland China-Durocs	Durocs	Crossbreds from sows of subsequent generations
Litters from gilts	10	12	2	4	15	18
Litters from sows	19	21	5	3	16	12
Average gestation, days	114.5	114.3	113.5	113.3	115.0	113.5
Live pigs per litter at birth	9.3	9.1	9.9	9.9	10.3	9.7
Dead pigs per litter at birth	0.4	0.3	0.4	0.4	0.5	0.4
Total pigs per litter at birth	**9.7**	**9.4**	**10.3**	**10.3**	**10.8**	**10.1**
Pigs per litter at weaning	6.4	6.4	6.4	7.4	7.0	8.1
Average adjusted weight at 56 days, lb.	31.2	36.2	32.3	31.6	36.8	36.9
Percent live pigs lost before weaning	**31.7**	**29.8**	**34.8**	**24.6**	**31.9**	**16.4**
Percent live pigs lost after weaning	2.6	0.7	0.0	1.4	2.8	1.7
Pigs per litter at 180 days	**6.1**	**6.4**	**6.4**	**7.3**	**6.7**	**8.0**
Average daily gain, birth to 180 days, lb.	0.99	1.11	1.10	1.05	1.06	1.13
Average weight per pig at 180 days, lb.	178.3	200.3	197.1	188.4	191.4	203.8
Average weight per litter at 180 days, lb.	**1094.5**	**1274.6**	**1267.3**	**1372.8**	**1290.6**	**1623.9**

TABLE 3.—Crossbred and purebred pigs from gilts and sows,* Miami County Experiment Farm

	D Durocs		E Poland China × Durocs		F Hampshire × Poland China-Durocs		G Crossbreds from sows of subsequent generations		H All crossbreds	
From	Gilts	Sows	Gilts	Sows	Gilts	Sows	Gilts	Sows	Gilts	Sows
Number of litters	25	36	12	21	4	3	18	12	34	36
Average gestation, days	114.7	114.5	114.2	114.3	113.5	113.0	113.6	113.4	113.8	113.9
Live pigs per litter at birth	9.2	10.6	9.7	8.8	10.5	9.0	9.8	9.6	9.8	9.1
Dead pigs per litter at birth	0.4	0.4	0.2	0.3	0.5	0.3	0.5	0.3	0.4	0.3
Total pigs per litter at birth	**9.6**	**11.0**	**9.9**	**9.1**	**11.0**	**9.3**	**10.3**	**9.9**	**10.2**	**9.4**
Pigs per litter at weaning	6.6	6.9	5.1	7.2	7.7	7.0	8.2	8.0	7.1	7.4
Average adjusted weight at 56 days, lb	30.9	36.6	34.5	37.3	29.6	35.8	34.0	41.2	33.8	38.8
Percent pigs lost before weaning	**27.5**	**34.2**	**47.4**	**18.8**	**26.2**	**28.6**	**16.4**	**16.5**	**28.1**	**17.7**
Percent pigs lost after weaning	2.6	2.4	1.7	0.0	2.4	0.0	2.3	0.9	2.1	0.3
Pigs per litter at 180 days	6.4	6.7	4.9	7.2	7.5	7.0	8.0	7.9	6.9	7.4
Average daily gain, birth to 180 days, lb	0.94	1.11	1.06	1.13	0.93	1.22	1.07	1.23	1.05	1.17
Average weight per pig at 180 days, lb	168.6	199.6	191.1	203.9	167.8	219.0	192.3	221.4	188.8	211.2
Average weight per litter at 180 days, lb	**1078.8**	**1336.3**	**939.4**	**1466.1**	**1258.5**	**1533.1**	**1538.2**	**1753.0**	**1294.1**	**1566.7**

*A difference other than the age of the dams was the time of year the litters were farrowed. All of the litters from gilts were farrowed in the fall, whereas, with the exception of the fall of 1944, all of the litters from sows were farrowed in the spring.

the first few days there was a greater loss among the purebreds than among the crossbreds. By weaning time, the purebreds averaged 1.1 and by market time, 1.3 fewer pigs per litter than the crossbreds. The crossbreds gained more rapidly and, at 180 days of age, averaged 12.4 pounds heavier than the purebreds. The difference in the rapidity of the gains was not as great as it was between the purebreds and the first-cross pigs by Poland China sires. Because of the number of pigs saved, the difference in the weight per litter at 180 days of age in favor of the crossbreds over the purebreds was greater in the subsequent than in the first two generations.

Parts D, E, F, G, and H of table 3 show the data separately for the gilt and sow litters from the matings (1) for the purebreds, (2) for the two-breed crossbreds, (3) for the three-breed crossbreds, (4) for the subsequent generations of crossbreds, and (5) for all of the crossbreds.

Since there were other variables, such as spring as against fall farrowing, the differences which occurred are not attributable entirely to the age of the sows at farrowing. The spring litters from sows weighed more at 180 days of age than the fall litters from gilts. Because of an unusually high death loss during the first few days after farrowing and a resulting small number of pigs saved per litter, the Poland China × Duroc litters from gilts compared less favorably with the purebred litters than did the Poland China × Duroc litters from sows.

TABLE 4.—Summary of crossbred and purebred pigs, Miami County Experiment Farm

	I		J		K	
	From gilts		From sows		All litters	
	Durocs	Cross-breds	Durocs	Cross-breds	Durocs	Cross-breds
Litters from gilts	25	34	.....	.....	25	34
Litters from sows	.....	.....	36	36	36	36
Average gestation, days	114.7	113.8	114.5	113.9	114.6	113.9
Live pigs per litter at birth	9.2	9.8	10.6	9.1	10.0	9.5
Dead pigs per litter at birth	0.4	0.4	0.4	0.3	0.4	0.3
Total pigs per litter at birth	**9.6**	**10.2**	**11.0**	**9.4**	**10.4**	**9.8**
Pigs per litter at weaning	6.6	7.1	6.9	7.4	6.9	7.3
Average adjusted weight at 56 days, lb	30.9	33.8	36.6	38.8	34.2	36.0
Percent live pigs lost before weaning	**27.5**	**28.1**	**34.2**	**17.7**	**31.7**	**23.4**
Percent live pigs lost after weaning	2.6	2.1	2.4	0.3	2.5	1.2
Pigs per litter at 180 days	**6.4**	**6.9**	**6.7**	**7.4**	**6.6**	**7.1**
Average daily gain, birth to 180 days, lb	0.94	1.05	1.11	1.17	1.04	1.12
Average weight per pig at 180 days, lb	168.6	188.8	199.6	211.2	187.2	200.8
Average weight per litter at 180 day	**1078.8**	**1294.1**	**1336.3**	**1566.7**	**1230.8**	**1434.3**

Parts I and J of table 4 show the data for the purebred and crossbred litters from gilts, and for the purebred and crossbred litters from sows, respectively. Part K summarizes the data for all of the purebred and all of the crossbred litters from both gilts and sows in the project at the Miami County Experiment Farm up to and including the 1945 spring crop of pigs.

An average of .5 pig more was saved from the crossbred than from the purebred litters. At 180 days of age the crossbreds weighed 203 pounds more per litter than the purebreds.

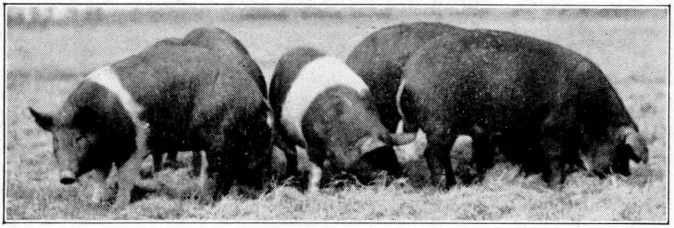

Fig. 5.—Purebred Hampshire and crossbred Poland China × Duroc-Hampshire gilts. Paulding County Experiment Farm, February 1938.

PAULDING COUNTY TESTS[2]

Crossbreeding projects were also started at the Paulding and Madison County Experiment Farms. At Paulding the crossbreds were compared with purebred Hampshires. Spring and fall pigs were raised but all of the litters were from gilts. The crossbred pigs were produced by rotating sires of the Duroc, Poland China, and Hampshire breeds on successive generations of gilts selected from the herd. Except for the dams of the first generation, which were Hampshires, the dams of the crossbred pigs were of mixed breeding.

To avoid the cost of purchasing and keeping a second boar, neighbors' boars were used to sire the crossbred pigs. Some of these were of rangy rather than of medium type. Possibly the quality of some was not equal to that of the sires of the purebred pigs. Differing from the results of the Miami County Farm, considerable variation in type in the crossbreds was obtained after the first generation.

The project was discontinued at the beginning of the second cycle. The breeding of the various crops of pigs and their performance, together with a summary of the results secured, are given in table 5. An average of 0.7 pig more was saved from the crossbred than from the purebred litters. At 180 days of age, the crossbred litters averaged 203 pounds heavier than the purebred litters.

MADISON COUNTY TESTS[3]

Four farm-bred gilts which were not registered but which were represented to be purebred Hampshires were secured by the Superintendent at the start of a crossbreeding project at the Madison County Experiment Farm. Two were mated to a Hampshire and two to a Duroc sire. Variations in the color of the pigs in the crossbred litters indicated that the dams were not purebreds. In the spring of 1937 they were replaced with four purebred Poland China gilts. One of the Poland Chinas proved pregnant when purchased rather than open as claimed. This resulted in three purebred and one crossbred litter rather than two of each as planned.

After the change to Poland Chinas was made the crossbreds were compared with purebred Durocs on one farm; with purebred Hampshires on another; and with purebred Poland Chinas on the third. Sires of these three breeds were used in the production of the crossbred pigs.

---

[2]M. A. Bachtell, in charge of District and County Farms and R. C. Beatty, Superintendent, collaborating.

[3]M. A. Bachtell, in charge of District and County Farms and H. W. Rogers, Superintendent, collaborating.

TABLE 5.—Purebred and crossbred pigs, Paulding County Experiment Farm

Breeding	Year	Season	Age of sows at farrowing (years)	No. of litters	Pigs per litter at birth		Pigs per litter at weaning	Weight per pig at 56 days	Pigs per litter at 180 days	Daily gain per pig to 180 days	Weight per pig at 180 days	Weight per litter at 180 days
					Live	Dead						
								Lb.		*Lb.*	*Lb.*	*Lb.*
H	1936	S.	1.0	1	5.0	0	4.0	42.7	4.0	1.03	186	743
D x H				1	7.0	0	5.0	36.1	5.0	0.92	165	825
H	1936	F.	1.0	3	3.7	2.0	3.0	21.9	3.0	0.68	122	367
D x H				2	7.5	0.5	6.0	28.9	6.0	0.93	167	1003
H	1937	S.	1.0	2	11.0	0	10.0	20.6	10.0	0.91	164	1638
P x D-H				2	8.5	0.5	8.5	31.3	8.5	1.05	189	1605
H	1937	F.	1.0	3	6.3	0.3	6.3	27.4	6.3	0.90	162	1027
P x D-H				2	7.5	0.5	7.0	25.1	7.0	1.00	179	1255
H	1938	S.	1.0	4	8.2	0.5	5.0	34.7	4.7	0.95	172	815
H x P-D-H				3	10.3	1.0	6.7	30.6	6.0	0.95	172	1029
H	1939	S.	1.0	3	8.3	1.3	6.7	28.6	6.7	0.84	152	1013
H x P-D-H				2	6.5	0	6.0	31.9	6.0	0.95	171	1027
H	1939	F.	1.0	5	5.8	0.2	5.2	23.1	4.6	0.87	157	722
D x H-P-D-H*				3	7.3	0.3	3.0	26.1	2.7	0.85	152	406
H	1940	S.	1.0	5	5.6	0.2	4.4	28.8	4.4	0.86	155	681
D x H-P-D-H				3	8.7	1.3	7.3	35.6	7.0	0.96	173	1214
Hampshires	.....	.....	1.0	26	6.3	0.6	5.3	27.3	5.2	0.88	158	827
Crossbreds	.....	.....	1.0	18	8.1	0.6	6.1	31.1	5.9	0.96	173	1030

*Two pigs in one litter had a nervous disorder. These weighed 10.5 and 16 pounds at 48 days, and 45 and 83 pounds, respectively, at 172 days of age. One in another litter with the same disorder weighed 10 pounds at 52 days and died later.

TABLE 6.—Purebred and crossbred pigs, Madison County Experiment Farm

Breeding	Year	Season	Age of sows at farrowing (years)	No. of litters	Pigs per litter at birth		Pigs per litter at weaning	Weight per pig at 56 days	Pigs per litter at 180 days	Daily gain per pig to 180 days	Weight per pig at 180 days	Weight per litter at 180 days
					Live	Dead						
								Lb.		*Lb.*	*Lb.*	*Lb.*
H	1936	F.	1.5	2	9.0	0.5	8.0	27.7	7.5	1.02	184	1377
D x H				2	8.5	0	8.5	35.1	8.5	1.15	207	1759
P	1937	F.	1.0	3	3.7	0	3.7	30.2	3.7	0.85	153	566
D x P				1	5.0	0	5.0	34.1	5.0	0.97	175	873
P	1938	S.	1.5	2	7.5	0.5	7.5	43.8	7.5	1.01	182	1363
D x P				2	8.0	0	7.0	53.5	7.0	1.14	205	1436
P	1939	S.	1.5	2	7.5	1.5	6.5	30.1	6.5	1.01	182	1182
H x D-P				2	8.5	0.5	8.5	39.8	8.5	1.16	209	1775
P	1939	F.	1.5	2	8.5	1.0	8.0	29.0	7.0	1.06	191	1336
H x D-P				1	8.0	0	6.0	32.6	6.0	1.23	221	1328
P	1940	S.	1.0	1	6.0	0	6.0	23.7	6.0	0.88	158	950
P x H-D-P				2	6.5	0.5	6.5	36.6	6.5	0.88	158	1030
P	1940	F.	1.5	2	7.5	0	7.5	41.0	7.5	0.96	173	1296
P x H-D-P				2	9.5	0.5	9.5	.....	9.5	0.89	160	1522
P	1941	S.	1.0	1	6.0	1.0	6.0	32.4	6.0	0.92	166	994
D x P-H-D-P				2	6.5	0.5	6.5	34.4	6.5	0.96	173	1123
P	1941	F.	1.5	2	6.0	0.5	5.0	51.4	5.0	1.19	214	1071
D x P-H-D-P				2	9.5	0.5	8.0	50.4	8.0	1.08	194	1555
Poland Chinas*	.....	.....	.....	15	6.5	0.5	6.1	34.7	6.0	0.99	178	1069
Crossbreds*	.....	.....	.....	14	7.9	0.4	7.4	41.0	7.4	1.03	185	1361

*Does not include 1936 fall litters.

Four generations of crossbreds rather than six, as originally planned, were produced. The six would have comprised two complete cycles. The data on each crop of pigs and a summary showing the average results for the Poland Chinas and for the crossbreds that were compared with them are presented in table 6. In one instance no weaning weight was taken. In others, the weaning weights were taken late but were adjusted to a basis of 56 days of age.

Averages of 6 purebred and 7.4 crossbred pigs were saved per litter. At 180 days of age, the crossbreds weighed 292 pounds more per litter than the purebreds.

OHIO AGRICULTURAL EXPERIMENT STATION TESTS

Early Trials

Feeding trials in which purebred pigs of the Duroc and Tamworth breeds and crossbred pigs of the two breeds were compared were carried on at the Ohio Agricultural Experiment Station in 1919 and 1922. Insufficient data were obtained then to warrant publication.

Purebred and Crossbred Litter Mates

In the fall of 1930, three Duroc sows were double mated to a Duroc sire and to a Yorkshire sire. They farrowed 13 purebred and 15 crossbred pigs and saved 9 of each. The pigs were used in a dry lot feeding trial. Four of the crossbreds and five of the purebreds were fed corn, tankage, cottonseed meal, ground alfalfa, and minerals. The cottonseed meal was fed at rates which averaged 4 pounds to each 100 pounds of total feed. To study the protective effect of tankage against cottonseed meal poisoning, the others were fed a similar ration except that it contained 20 percent of cottonseed meal. In previous tests, deaths were caused by the cottonseed meal when it was fed at this high level with no tankage. The larger amount of cottonseed meal resulted in relatively slow gains. During the test the pigs getting the ration containing 4, and those getting the one containing 20 percent of the cottonseed meal gained 1.35 and 1.15 pounds daily a head, respectively. Table 7 shows the individual and average gains made from birth by the purebred pigs and their crossbred litter mates.

When 210 days of age, the purebreds averaged 217 and the crossbreds, 228 pounds in weight. The crossbreds reached an average weight of 220 pounds 11 days earlier than their purebred litter mates.

Performance of Purebreds and Crossbreds on Pasture

Because of a lack of help and facilities, careful studies of the relative gains made per unit of feed consumed by purebred and crossbred pigs could not be carried on at the County Experiment Farms. To secure information on the efficiency of feed utilization as well as further data on the number of pigs farrowed and saved and the rapidity of the gains made by purebred and crossbred pigs, a series of crossbreeding tests was started at the Ohio Agricultural Experiment Station in 1938.

**TABLE 7.—Purebred and crossbred pigs from double-mated sows*
(Pigs fed in dry lot)**

No. of dam	Pig No.	Sex	Farrowed 1931	Days of age, Aug. 12	Weight, Aug. 12 Lb.	Average daily gain Lb.	Days to reach 220 lb.
Purebred Durocs							
84	301	M	Jan. 14	210	239.0	1.14	194
	302	M		210	186.5	0.89†	248
200	307	M	Jan. 15	209	179.0	0.86	257
	308	F		209	219.0	1.05†	210
	309	M		209	265.0	1.27	174
	310	M		209	152.0	0.73†	303
94	315	M	Jan. 18	206	219.0	1.06	207
	316	M		206	253.0	1.23†	180
	317	M		206	216.0	1.05	210
Average				208.2	**214.3**	**1.03**	214
Crossbred Yorkshire x Durocs							
84	303	M	Jan. 14	210	231.5	1.10†	200
	304	M		210	290.5	1.38	160
	305	M		210	190.0	0.90†	244
200	306	F	Jan. 15	209	209.5	1.00†	220
	311	F		209	244.5	1.17	189
	312	F		209	204.0	0.98	226
	313	F		209	184.0	0.88†	250
94	314	F	Jan. 18	206	230.5	1.12	197
	318	M		206	255.0	1.24†	178
Average				208.7	**226.6**	**1.09**	203

*The three sows farrowed 10 male and 3 female purebred Durocs and 6 male and 9 female crossbred Yorkshire × Duroc pigs. They saved the number of each shown in the table.

†To study the effect of tankage in overcoming the toxic effect of cottonseed meal, these pigs were fed a ration of corn, 67.5; tankage, 8; cottonseed meal, 20; ground alfalfa, 3; minerals, 1. The others were fed a ration of corn, 81.1; tankage, 9.6; cottonseed meal, 4.8; ground alfalfa, 3.0; minerals, 1.5 until they averaged 120 pounds in weight, and thereafter one of corn, 85.3; tankage, 6.8; cottonseed meal, 3.4; ground alfalfa, 3; minerals, 1.5.

The purebreds and the crossbreds on the higher percentage of cottonseed meal gained 82.2 and 86.3 percent as much as the purebreds and crossbreds, respectively, on the lower percentage of cottonseed meal. Based on the lower level of cottonseed meal, the purebreds gained 1.09 and the crossbreds, 1.14 pounds daily a head from birth to 208 days of age.

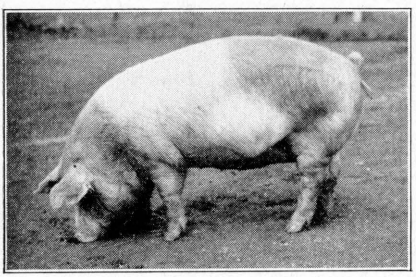

Fig. 6.—Crossbred O. I. C. × Duroc, 1933. Note the color marking, which was characteristic of approximately half of the pigs. The remainder were white but some of them had dark skin at the rump under the white hair.

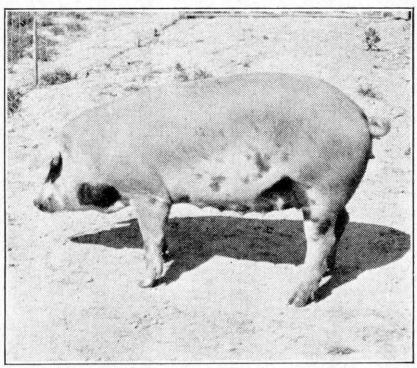

Fig. 7.—Crossbred Poland China × Duroc gilt, at 10 months of age.

In an experiment on pasture, pigs of a two-breed cross, a three-breed cross, a three-breed backcross, and a two-breed backcross were compared with purebred Durocs. Each group was started when the pigs averaged approximately 50 and discontinued when they averaged approximately 200 pounds in weight.

TABLE 8.—Purebred and crossbred pigs on pasture

Experiment conducted summer of 1938 Dwarf Essex rape pasture used Feeds mixed and self fed	1 Durocs	2 Berkshire x Durocs	3 Berkshire x Poland China-Durocs	4 Durocs x Berkshire-Poland China-Durocs	5 Durocs x Berkshire-Durocs
Pigs at start	12	12	12	11	7
Average days of age at start	78.2	75 2	82.9	75.7	79
Initial weight per pig, lb.	54.5	51.9	52.8	53.6	51.5
Pigs at close	12	12	12	11	7
Final weight per pig, lb.	198.8	202.9	199.1	207.4	207.2
Average daily gain during test, lb.	1.29	1.27	1.39	1.47	1.39
Average daily gain from birth, lb.	**1.04**	**1.04**	**1.06**	**1.14**	**1.08**
Days from birth to reach a weight of 200 pounds	192	192	189	175	185
Daily feed per pig, lb.:					
Corn	4.50	4.37	4.62	4.76	4.26
Fish meal	.51	.49	.51	.55	.48
Minerals	.03	.03	.03	.03	.02
Total	5.04	4.89	5.16	5.34	4.76
Feed per 100 lb. gain, lb.:					
Corn	349.22	344.94	331.37	325.15	306.17
Fish meal	39.76	38.32	36.63	37.37	34.62
Minerals	1.98	2.19	2.15	1.75	1.79
Total	**390.96**	**385.45**	**370.15**	**364.27**	**342.58**

TABLE 9.—Relative gains made by Duroc and by Berkshire × Duroc pigs. 1938

Lot	Breeding	No. of pigs	Average daily gain during test	Average daily gain from birth	Days from birth to reach a weight of 200 lbs.
			Lb.	*Lb.*	
1	Duroc	12	1.35	1.07	187
	Berkshire x Duroc	8	1.27	1.06	189
2	Duroc	12	1.27	1.05	190
	Berkshire x Duroc	8	1.13	0.98	203
3	Duroc	12	1.41	1.13	177
	Berkshire x Duroc	8	1.27	1.06	190
4	Duroc	12	1.33	1.17	171
	Berkshire x Duroc	8	1.34	1.10	182
5	Duroc	12	1.26	1.04	192
	Berkshire x Duroc	8	1.20	1.02	197
All	**Duroc**	**60**	**1.32**	**1.09**	**184**
	Berkshire x Duroc	**40**	**1.24**	**1.04**	**192**

The rations were composed of corn, minerals, and a protein concentrate. The protein concentrates were: lot 1, meat and bone scraps; lot 2, dry rendered tankage; lot 3, fish meal; lot 4, toasted extracted soybean oil meal; and lot 5, expeller cottonseed meal, treated with a solution of ferrous sulfate. The feeds were mixed and self fed.

The pigs were on mixed clover and alfalfa pasture.

Excellent Berkshire boars from the Raymond Martin herd and by an Ohio State Fair grand champion, sired the crossbred pigs.

The two-breed or first-cross pigs made slightly greater gains per unit of feed consumed but gained at practically the same rate as the purebreds. There was very little difference in the performance of the two groups. Both the purebreds and the first-cross pigs were surpassed in rapidity of gains and in gains per unit of feed by the other three groups. The three-breed back-cross pigs made the most rapid gains but stood second to the two-breed back-cross pigs in gains per unit of feed.

In the same year, in a trial on pasture in which different protein concentrates were compared, five groups of pigs were used. Each group contained 12 purebred Duroc and 8 crossbred Berkshire × Duroc pigs. In four of the five groups, the purebreds outgained the crossbreds. The pigs averaged approximately 57 pounds at the beginning and 202 pounds at the close of the experiment. During the experiment, the purebreds and the crossbreds gained 1.32 and 1.24 pounds daily a head, respectively. From birth, the purebreds and the crossbreds made average gains of 1.09 and 1.04 pounds daily a head, respectively. The purebred Durocs reached a weight of 200 pounds 8 days earlier than the crossbred Berkshire × Durocs. A summary of the results is presented in table 9.

Effect of Size of Parent Stock

Smith (8) states that size of individuals represented in the parentage of an animal has an important influence on its gaining ability. Table 10 shows the average weights of the prize winning boars and sows of the various breeds and of the different age classifications at the National Swine Show from 1922 to 1933, inclusive (9). These weights show that the breeds exhibited varied in size at maturity and that the breeds which were heavier than others at maturity were also heavier at the younger ages.

TABLE 10.—Average weights of National Swine Show prize winners. 1922 to 1933, inclusive

	Boars					Sows				
	Aged	Senior yearlings	Junior yearlings	Senior pigs	Junior pigs	Aged	Senior yearlings	Junior yearlings	Senior pigs	Junior pigs
Poland Chinas	966	958	703	481	218	796	690	617	455	221
Durocs	903	730	702	501	220	756	679	602	459	212
Spotted Polands	840	654	584	415	199	711	622	540	426	196
Chester Whites	801	651	579	390	208	695	609	546	413	207
Berkshires	747	629	538	383	185	650	569	528	389	184
Hampshires	664	521	455	330	159	619	509	434	323	160
Yorkshires	672	555	497	365	179	597	508	508	370	184
Tamworths	678	539	438	313	164	617	530	458	326	165

Published through the courtesy of the Daily Drovers' Journal, Chicago.

In later trials, in order to secure further information on the influence of size, both Poland China and Berkshire sires were mated to Duroc sows. According to table 10, Poland Chinas and Durocs are among the larger, whereas Berkshires and Hampshires are among the smaller of the leading lard-type breeds.

TABLE 11.—Summary of crossbred litters until weaned, Ohio Agricultural Experiment Station

	Berkshire x Duroc		Poland China x Duroc		Berkshire x Poland China-Duroc		Poland China x Berkshire-Duroc		Duroc x Berkshire-Duroc*		Duroc x Berkshire-Poland China-Duroc	
From	Gilts	Sows	Gilts	Sows	Gilts	Sows	Gilts	Sows	Gilts	Sows	Gilts	Sows
Litters	10	11	3	6	3	1	1	8	5	6	4	6
Av. gestation, days	114.7	114.3	115.0	114.5	114.7	116.0	115.0	114.9	113.6	113.8	115.0	114.5
Live pigs per litter at birth	8.1	9.6	7.4	9.8	6.3	10.0	10.0	9.2	9.0	10.7	7.0	9.7
Dead pigs per litter at birth	0.5	0.4	0.3	1.2	0.3	0.0	1.0	0.4	0.2	0.3	0.0	0.3
Total pigs per litter at birth	8.6	10.0	7.7	11.0	6.7	10.0	11.0	9.6	9.2	11.0	7.0	10.0
Av. weight of pigs dead at birth	2.5	2.3	3.0	2.0	.....	.....	3.3	3.6	.....	1.4	.....	2.1
Died before weaning:												
Av. per litter	1.4	2.0	0.3	3.8	0.0	1.0	0.0	2.7	1.8	4.0	0.7	2.0
Percent of total	**17.3**	**20.8**	**4.5**	**39.0**	**0.0**	**10.0**	**0.0**	**29.7**	**20.0**	**37.5**	**10.7**	**20.7**
Av. days old at first weight	1.6	2.6	0.0	2.1	.....	1.0	.....	1.3	1.3	1.9	2.3	3.7
Av. first weight, lb.	2.7	4.0	2.1	2.6	.....	3.5	.....	2.9	2.4	2.9	3.1	3.0
Lived to weaning:												
Av. per litter	**6.7**	**7.6**	**7.0**	**6.0**	**6.3**	**9.0**	**10.0**	**6.5**	**7.8**	**6.7**	**6.2**	**7.7**
Av. days old at first weight	2.5	4.4	1.3	2.7	2.4	1.0	3.0	2.0	2.2	3.4	2.6	3.8
Av. first weight, lb.	3.6	4.3	3.6	4.1	4.4	3.5	4.2	3.9	3.3	4.4	3.8	**4.1**
Weight per pig at 56 days, adjusted	27.6	37.4	27.9	40.2	32.8	35.8	41.4	38.0	29.5	39.0	33.2	39.3
Weight per litter at 56 days, adjusted	**185.0**	**285.5**	**195.5**	**241.5**	**207.6**	**303.8**	**413.7**	**246.9**	**230.0**	**260.0**	**207.5**	**301.4**

*One sow in this group was a Poland China × Duroc, making the breeding of the litter Duroc × Poland China-Duroc.

Effect of Age of Dam

The crossbreeding experiments were continued from 1938 to 1942. In addition to mating Berkshire and Poland China sires to Duroc sows, sires of the two breeds were also mated to crossbred Poland China × Duroc and Berkshire × Duroc sows, respectively. Other crosses made were (1) a two-breed backcross in which Berkshire × Duroc sows were mated to a Duroc sire, and (2) three-breed backcrosses in which Berkshire × Poland China-Duroc or Poland China × Berkshire-Duroc sows were mated to Duroc sires. The purebreds with which the crossbreds were compared were Durocs.

Table 11 shows the number of gilt and sow litters produced by the different matings and gives the data for the various groups to weaning. The Poland China × Duroc pigs were slightly heavier at 56 days of age than were the Berkshire × Duroc pigs. More of the latter than of the former were saved per litter.

Table 12 summarizes the data for the litters that were (1) out of purebred Duroc dams and by purebred sires of the same breed, (2) out of purebred Duroc dams and by purebred sires of a different breed, and (3) out of crossbred dams and by purebred sires.

TABLE 12.—Comparison of purebred and two types of crossbred litters—those from purebred and those from crossbred dams

	Purebred litters		First-cross litters		Subsequent cross litters	
From	Gilts	Sows	Gilts	Sows	Gilts	Sows
Litters	8	30	13	17	13	21
Average gestation, days	114.5	113.8	114.8	114.4	114.4	114.5
Live pigs per litter at birth	9.1	10.8	7.9	9.7	7.9	9.8
Dead pigs per litter at birth	0.3	0.9	0.5	0.7	0.2	0.3
Total pigs per litter at birth	9.4	11.7	8.4	10.4	8.1	10.1
Average weight of pigs dead at birth, lb		1.8	2.6	2.1	3.3	2.1
Died before weaning:						
Average per litter	2.0	3.4	1.2	2.6	0.7	2.8
Percent of total	**21.9**	**31.5**	**14.6**	**27.3**	**11.8**	**28.6**
Av. days old at first weight	0.9	1.6	1.5	2.3	1.7	2.0
Av. first weight, lb	2.2	2.2	2.6	3.3	2.6	2.9
Lived to weaning:						
Average per litter	7.1	7.4	6.8	7.1	7.2	7.0
Av. days old at first weight	3.6	3.1	2.2	3.9	2.4	2.9
Av. first weight, lb	3.6	3.6	3.6	4.3	3.7	4.1
Weight per pig at 56 days, adjusted, lb	29.3	33.8	27.7	38.3	32.8	38.5
Weight per litter at 56 days, adjusted, lb	**208.8**	**250.0**	**187.5**	**270.1**	**234.8**	**269.4**

Both the purebred and first-cross pigs were out of purebred dams of the same breed. A larger percentage of the crossbred pigs than of the purebred pigs farrowed alive survived but, because of fewer pigs to begin with, the first-cross litters contained fewer pigs at weaning time than the purebred litters. In the case of those produced by sows, both the first-cross individuals and litters averaged heavier at 56 days of age than the purebred individuals and litters. In the case of those produced by gilts, the opposite was true.

Regardless of the age of the dams, when the pigs were by purebred sires but out of crossbred dams, both the individuals and the litters were heavier at 56 days of age than were the purebred individuals and litters.

TABLE 13.—Summary of litter records of Duroc sows of different ages, Ohio Agricultural Experiment Station

Age of sows at farrowing, years ☞	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	All except gilts	All including gilts
Number of sows	107	83	70	65	55	49	39	20	8	389	496
Average gestation, days	113.9	113.4	113.1	113.0	111.4	113.3	113.0	112.8	113.7	112.9	113.1
Live pigs per litter at birth	**9.4**	**9.9**	**11.2**	**11.1**	**10.5**	**10.5**	**10.2**	**10.6**	**9.9**	**10.6**	**10.3**
Dead pigs per litter at birth	.2	.4	.5	.7	.8	1.3	1.3	1.4	2.6	.8	.7
Total pigs per litter at birth	9.6	10.3	11.7	11.8	11.3	11.8	11.5	12.0	12.5	11.4	11.0
Sex, boars, percent	50.1	51.2	49.9	47.9	52.9	52.8	49.0	47.3	50.0	50.4	50.3
sows, percent	49.3	48.2	49.2	50.9	46.6	46.9	48.8	50.2	47.0	48.6	48.8
unknown, percent	0.6	0.6	0.9	1.2	0.5	0.3	2.2	2.5	3.0	1.0	0.9
Av. weight of pigs dead at birth, lb	2.1	2.1	2.2	2.3	2.1	1.9	2.2	2.2	2.3	2.2	2.2
Died before weaning:											
Average per litter	2.4	2.6	3.8	4.0	3.5	3.8	4.2	4.6	3.9	3.6	3.4
Percent of total	26.0	25.8	34.3	36.2	33.7	36.4	40.7	43.9	39.2	34.3	32.7
Av. days old at first weight	1.7	1.3	1.4	1.2	1.4	1.6	1.8	1.4	1.8	1.4	1.5
Average first weight, lb	2.4	2.5	2.6	3.1	2.3	2.4	2.5	2.3	2.1	2.6	2.5
Lived to weaning:											
Average per litter	**6.9**	**7.3**	**7.2**	**6.8**	**6.8**	**6.6**	**5.8**	**5.7**	**6.0**	**6.8**	**6.8**
Av. days old at first weight	2.9	2.4	3.0	2.6	2.6	2.9	3.1	2.4	2.9	2.7	2.7
Average first weight, lb	3.4	3.6	3.9	3.5	3.5	3.5	3.7	3.3	3.3	3.6	3.6
Weight per pig at 56 days, adjusted*	28.2	33.6	34.2	34.0	34.9	34.3	33.3	34.1	32.5	34.0	32.8
Weight per litter at 56 days, adjusted*	**193.5**	**245.4**	**245.4**	**230.5**	**231.4**	**226.3**	**192.8**	**196.2**	**174.8**	**229.8**	**222.8**

*"Adjusting Weights of Pigs to a Standard Age of 56 Days," Whatley, J. G., Jr., Quaife, E. L.; 1937. Amer. Soc. Anim. Prod. Rec. Proc. 30: 126-130.

The data given for the Durocs are for the litters from which pigs were used in the trials to study the relative amounts of feed required per unit of gain by the purebreds and the various types of crossbreds. Table 13 summarizes recent Ohio Experiment Station records of Duroc litters from sows of different ages and includes the data for a larger number of litters.

Gilts averaged fewer pigs per litter than sows. They saved a somewhat larger percentage of those farrowed, but, as indicated by the lighter weight of their litters at weaning time, did not have the capacity to nurse their pigs as well as did the older sows. The sows over 2.5 years of age farrowed as many total pigs per litter as the younger sows. Since more of their pigs were stillborn and since they also lost a larger percentage of those farrowed alive, their litters contained a smaller average number of pigs at weaning than did those of the 1.5 and 2.0 year old sows. Regardless of the age of the sows, the greatest losses occurred the first few days after farrowing.

In the herd, a continual process of selection is practiced. This results in the elimination of a number of young sows after their first litters are weaned and in the discarding of sows of other ages when something has gone wrong or when they have ceased to produce satisfactory litters. Consequently, as the age increases, the number of sows involved decreases.

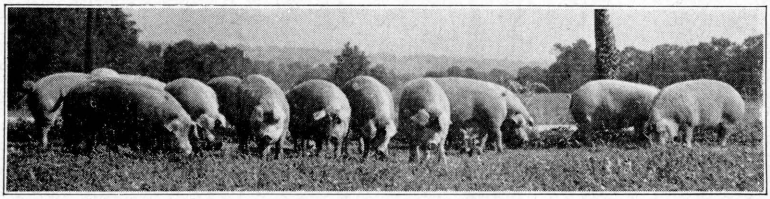

Fig. 8.—Group of Duroc brood sows, Ohio Agricultural Experiment Station, 1941.

How the same sows perform at different ages may be of interest. Since 1910, in the Experiment Station herd 38 sows have been kept until they were 5 or more years of age. Five of these farrowed their first litters when they were approximately 1.5 years of age. Twenty of the remainder were not bred or else failed to conceive and were not rebred in one or two seasons. Thirteen of the 38 farrowed their first litters when they were approximately a year of age and farrowed regularly, or twice a year, thereafter until they were 5 years or more of age. The data for their litters is presented in table 14.

Most of the gilts that were selected for the breeding herd had previously been on feeding experiments. Some of the sows whose records are included in the data in table 14 date back to a period when a larger number of deficient experimental rations were fed than in recent years. Possibly this had an adverse influence on the number of pigs farrowed at the younger ages. Possibly, too, the more recent management practices were improvements over those formerly employed.

Sows a year of age saved a higher percentage of their pigs but did not have or save as many per litter then, nor nurse them as well as they did those that were farrowed when the sows were 2 and 2.5 years of age. After the sows were 4.0 years of age, in each successive farrowing, the average number of pigs saved per litter decreased.

TABLE 14.—Litter records of sows carried to 5 or more years of age without missing a farrowing season

Age of sows at farrowing, years ☞	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Number farrowing	13	13	13	13	13	13	13	13	13
Av. gestation, days	113.9	112.6	114.1	113.2	113.0	113.1	112.9	113.5	113.8
Live pigs per litter at birth	8.4	9.2	10.4	11.7	10.2	11.6	11.1	10.3	9.6
Dead pigs per litter at birth	0.2	0.1	0.4	0.7	1.4	1.6	1.2	1.0	1.5
Total pigs per litter at birth	**8.6**	**9.3**	**10.8**	**12.4**	**11.6**	**13.2**	**12.3**	**11.3**	**11.1**
Av. weight of pigs dead at birth, lb.	1.4	2.1	1.5	1.7	1.7	1.7	1.6	1.9	1.7
Died before weaning:									
Av. per litter	1.8	2.7	3.2	4.0	4.4	4.8	4.4	4.5	4.5
Percent of live pigs	22.0	29.2	31.1	34.2	42.9	41.3	39.6	43.3	47.6
Av. days old when weighed	0.4	1.2	1.2	0.7	0.6	1.0	1.0	0.9	1.1
Av. weight, lb.	1.8	2.2	2.0	2.0	1.9	1.9	1.9	2.1	1.9
Lived to weaning:									
Av. per litter	**6.5**	**6.5**	**7.1**	**7.7**	**6.4**	**6.8**	**6.6**	**5.9**	**5.0**
Av. days old when weighed	1.2	1.9	1.9	1.3	1.5	2.2	2.2	2.2	2.0
Av. weight, lb.	2.5	2.8	3.1	2.7	2.6	2.8	2.8	2.9	2.8
Weight per pig at 56 days, adjusted	24.4	28.2	29.3	31.5	31.8	30.3	30.8	28.6	31.7
Weight per litter at 56 days, adjusted, lb.	**159.5**	**184.6**	**207.0**	**242.0**	**203.1**	**205.2**	**204.1**	**169.7**	**158.3**

Table 15 is taken from the February, 1945, issue of the Duroc News (5). It summarizes the records of the litters of the Production Registry candidates in the Duroc breed from 1938 to 1944, inclusive. Doubtless, the performance of the candidates in the Production Registry program is above the average. Presumably, it is representative of the better animals of the breed. The data are of interest here for purposes of comparison. They indicate that the performance of the purebred animals whose records are reported in table 13 is not far out of line with that to be expected in good herds of the breed.

TABLE 15.—Summary of Duroc Production Registry records* 1938-1944, inclusive

	Gilts†	Sows
Number of litters	1335	1875
Average pigs farrowed per litter	10.2	11.8
Average pigs weaned per litter	7.9	8.3
Percent pigs lost	22.6	29.5
Weight per pig at 56 days, lb.	32.4	36.9
Weight per litter at 56 days, lb.	261.4	306.0

*Compiled from officially witnessed 56-day weight reports of 3,210 purebred Duroc litters. Includes 56-day records received in the National Duroc Herd Production Contest which required reports on every sow in the herd.

†Fifteen months of age or under at farrowing.

From page 30 "Duroc News", Vol. 19, No. 2, Feb., 1945.

The Ohio Experiment Station gilts and sows farrowed averages of 9.4 and 10.6 live pigs per litter and saved 74.0 and 65.7 percent of them to weaning time, respectively. The gilts and sows that were candidates for the Production Registry farrowed averages of 10.2 and 11.8 pigs per litter and saved 77.4 and 70.5 percent of them to weaning time, respectively.

Breeds Crossed May Influence Pigs Per Litter

Table 16 is from Technical Bulletin Number 836, "Litter Size and Weight as Permanent Characteristics of Sows" of the United States Department of Agriculture (7). It summarizes the farrowing records of herds maintained by

TABLE 16.—Number of pigs farrowed per litter

Breed ☞	Yorkshire	Duroc	Chester White	Hampshire	Poland China	Berkshire
Number of litters included	194	3337	832	267	1851	483
Age of sow, years 1.0	9.5	8.7	8.4	7.9	7.0	7.0
1.5	10.4	9 2	8.2	8.1	7.5	7.3
2.0	11.8	10.1	10.0	8.7	8.7	7.9
2.5	10.6	10.2	9.8	9.2	8.6	8.2
3.0	12.5	10.6	10.2	9.9	9.0	8.1
3.5	12.4	10.6	10.3	9.6	8.6	8.7
4.0	11.6	10.5	10.3	7.7	8.4	8.0
4.5	12.3	10.9	10.3	9.3	7.8	8.4
5.0	11.0	10.2	9.7	13.0	8.1	7.7
5.5	14.0	9.1	10.4	6.0	8.0	8.8
6.0	12.0	9.8	8.0	.....	8.5	8.0
6.5	7.0	11.0	7.0	7.0	7.0	8.4
7.0	.....	9.5	.....	13.0	5.0	7.2
7.5	.....	11.0	.....	11.0	.....	9.0
8.0	.....	.....	.....	.....	.....	9.5
Average	10.7	9.8	9.3	8.7	8.0	7.7

From Table 2—U. S. D. A. Tech. Bul. 836, "Litter Size and Weight as Permanent Characteristics of Sows," October, 1942.

the Bureau of Animal Industry of the United State Department of Agriculture and by eight state agricultural colleges and experiment stations. In most instances, the period covered was from the late 1920's to and including the spring of 1937. For some of the breeds the number of litters included is not large and the data for them may not be representative of the breed as a whole. The authors, Lush and Molln, however, state that there were unmistakable differences in litter size between the breeds.

Performance of Crossbreds from Purebred Dams

The feeding tests in which purebreds and pigs from the different types of crosses were compared were started when the pigs were from 50 to 60 pounds in weight. The different groups rather than being fed for a given length of time were carried to approximately the same final weights. To make the conditions as nearly similar as possible, both the spring and the fall pigs were confined indoors or fed in dry lots. A standard ration was used in all of the tests.

Under A and B of table 17 trials in which purebred Durocs were compared with Berkshire × Durocs and Poland China × Durocs, respectively, are summarized. Pigs out of Duroc dams and by Berkshire sires made no faster gains and no greater gains per unit of feed than purebred Durocs.

TABLE 17.—Gains and feed requirements of purebred and first-cross pigs
Pigs fed in dry lots

	A		B	
	Durocs	Berkshire x Durocs	Durocs	Poland x Durocs
Number of comparisons	6	6	5	5
Pigs at start	68	63	54	52
Average days of age at start	80.8	77.0	87.9	76.0
Initial weight per pig, lb.	51.6	51.2	55.2	57.6
Pigs at close	67	59	54	51
Final weight per pig, lb.	219.9	218.0	220.5	218.2
Average daily gain during test, lb.	1.36	1.35	1.41	1.42
Average daily gain from birth, lb.	**1.07**	**1.06**	**1.07**	**1.15**
Days to reach weight of 220 lb.	205	208	205	191
Daily feed per pig, lb.:				
Corn	4.24	4.28	4.37	4.32
Oats	.10	.09	.14	.10
Tankage	.36	.37	.38	.37
Soybean oil meal	.36	.37	.38	.37
Ground alfalfa	.21	.21	.21	.21
Minerals	.08	.08	.08	.09
Total	5.35	5.40	5.56	5.46
Feed per 100 lb. gain, lb.:				
Corn	312.48	316.65	310.47	304.94
Oats	7.26	6.48	9.93	6.81
Tankage	26.44	27.18	26.59	26.19
Soybean oil meal	26.44	27.18	26.59	26.19
Ground alfalfa	15.35	15.65	15.04	14.89
Minerals	6.22	6.33	6.21	6.07
Total	**394.19**	**399.47**	**394.83**	**385.09**

During the tests, and from birth to an average weight of approximately 220 pounds, the Poland China × Duroc pigs gained 0.8 and 7.5 percent faster, respectively, than the purebred Durocs. The more rapid gains of the Poland China × Duroc crossbred pigs, which occurred chiefly in the earlier stages of their development, enabled them to be marketed 2 weeks earlier on the average than the purebred Durocs.

The Poland China × Duroc pigs required less feed per unit of gain than the purebred Durocs. As pigs increase in fatness the feed required per unit of gain increases. Pigs which have not shown as strong a growth impulse are fatter at a given weight than are those of a more growthy type. Possibly the relative degrees of finish of the purebred and crossbred pigs when the tests were closed were wholly or partially responsible for the differences in the amounts of feed required per unit of gain.

Performance of Crossbreds from Crossbred Dams

Part C of table 18 gives the results of tests in which pigs by Berkshire sires and from Poland China × Duroc dams were compared with Durocs. Part D of table 18 gives the results of tests in which pigs by Poland China sires and from Berkshire × Duroc dams were compared with Durocs. The two columns at the right combine the data in C and D, that is, summarize the results secured in the tests in which purebreds and pigs of a three-breed cross were compared.

TABLE 18.—Gains and feed requirements of purebred pigs and pigs of a three-breed cross
Pigs fed in dry lots

	C		D		C and D	
	Durocs	Berkshire x Poland-Durocs	Durocs	Poland x Berkshire-Durocs	Durocs	Three-breed cross
Number of comparisons	4	4	3	3	7	7
Pigs at start	50	43	39	33	89	76
Av. days of age at start	89	79	87	75	88	77
Initial weight per pig, lb.	56.8	54.7	52.8	51.2	55.0	53.2
Pigs at close	50	43	39	33	89	76
Final weight per pig, lb.	216.4	214.0	213.4	214.5	215.1	214.2
Av. daily gain during test, lb.	1.38	1.42	1.39	1.36	1.38	1.39
Av. daily gain from birth, lb.	**1.04**	**1.12**	**1.06**	**1.10**	**1.06**	**1.11**
Days to reach a wt. of 220 lb.	212	197	208	200	208	198
Daily feed per pig, lb.:						
Corn	4.15	4.18	4.06	3.93	4.11	4.06
Oats	.26	.26	.35	.31	.30	.28
Tankage	.36	.37	.36	.36	.36	.37
Soybean oil meal	.36	.37	.36	.36	.36	.37
Ground alfalfa	.20	.20	.19	.18	.20	.20
Minerals	.09	.09	.08	.08	.08	.08
Total	5.42	5.47	5.40	5.22	5.41	5.36
Feed per 100 lb. gain, lb.:						
Corn	300.54	294.47	292.68	288.86	297.08	292.00
Oats	18.88	18.31	25.14	23.08	21.63	20.41
Tankage	26.30	26.30	25.82	26.23	26.09	26.27
Soybean oil meal	26.30	26.30	25.82	26.23	26.09	26.27
Ground alfalfa	14.41	14.22	13.65	13.61	14.08	13.95
Minerals	6.16	6.06	5.98	5.94	6.08	6.01
Totals	**392.59**	**385.66**	**389.09**	**383.95**	**391.05**	**384.91**

Regardless of the way the cross was made, the three-breed cross pigs gained somewhat faster and required a little less feed per unit of gain than the purebreds. They were ready for market 10 days earlier, on the average, than were the purebreds.

If crossing increases vigor, crossbred sows should be more vigorous than purebred sows and the resulting increase in vigor should be manifested in other respects as well as in rapidity of gains.

Part E of table 19 summarizes the results of five tests in which pigs by Duroc sires and out of Berkshire × Duroc dams were compared with purebred Durocs. There was very little difference in either the average daily gain or in the average amount of feed required per unit of gain by pigs from the two types of matings.

TABLE 19.—Gains and feed requirements of purebred pigs and of two-breed and three-breed backcross pigs

Pigs fed in dry lots

	E		F	
	Durocs	Durocs x Berkshire-Durocs	Durocs	Durocs x Berkshire-Poland China-Durocs
Number of comparisons	5	5	2	2
Pigs at start	51	43	22	20
Av. days of age at start	87	82	86	84
Initial weight per pig, lb.	55.5	56.8	58.0	59.2
Pigs at close	51	42	21	20
Final weight per pig, lb.	221.4	218.0	223.9	223.0
Average daily gain during test, lb.	1.38	1.35	1.42	1.57
Average daily gain from birth, lb.	**1.07**	**1.09**	**1.11**	**1.18**
Days to reach a weight of 220 lb.	206	203	199	186
Daily feed per pig, lb.:				
Corn	4.45	4.28	4.76	4.84
Oats				
Tankage	.37	.36	.37	.38
Soybean oil meal	.37	.36	.37	.38
Ground alfalfa	.22	.21	.24	.24
Minerals	.09	.08	.09	.10
Total	5.50	5.29	5.83	5.94
Feed per 100 lb. gain, lb.:				
Corn	321.60	317.05	335.03	308.18
Oats				
Tankage	26.81	26.48	26.08	24.22
Soybean oil meal	26.81	26.48	26.08	24.22
Ground alfalfa	16.03	15.81	16.86	15.49
Minerals	6.32	6.24	6.45	5.97
Total	**397.57**	**392.06**	**410.50**	**378.08**

Part F of table 19 summarizes the results of two tests in which three-breed backcross pigs—that were by Duroc sires and out of Berkshire-Poland China-Duroc dams—were compared with purebred Durocs.

The three-breed backcross pigs were not only ready for market 13 days earlier but also required an average of 7.9 percent less feed per unit of gain than did the purebreds. More data are needed before conclusions are warranted but both at the Experiment Station and at the Miami County Experiment Farm, when it was beyond the second generation, the plan of rotating purebred sires of three breeds on successive generations of sows selected from the herd, notwithstanding that they were of mixed breeding, made an excellent showing.

SUMMARY

Miami County Experiment Farm

At the Miami County Experiment Farm, a plan of crossbreeding was followed, in which Poland China, Hampshire, and Duroc sires were rotated on successive generations of sows selected from the herd. The original sows were Durocs. Two cycles of the rotation with a fall and a spring litter in each generation were completed and some additional first-cross pigs were produced. The crossbreds were compared with purebred Durocs.

Nineteen crops of pigs in which purebreds and crossbreds were compared were produced. In 15 of these, a greater number of crossbreds than of purebreds was saved per litter to 180 days of age. In 16 of the 19 crops of pigs, the crossbreds gained more rapidly than the purebreds. In 18 of the 19 crops, the average weight per litter at 180 days of age was in favor of the crossbreds.

In the order named, averages of 0.3, 0.9, and 1.3 more crossbred than purebred Duroc pigs were saved per litter to 180 days of age, when (a) the crossbreds were from Duroc dams and by Poland China sires, when (b) the crossbreds were from first-cross dams of Poland China × Duroc breeding and by Hampshire sires and, when (c) the crossbreds were from dams of the subsequent generations of the rotation plan of crossbreeding followed. For the three groups, the average differences in weight per litter at 180 days of age in favor of the crossbreds were 180, 105, and 333 pounds, respectively.

The crossbred pigs were ready for market 15 days earlier, on the average, than were the purebred pigs.

Paulding County Experiment Farm

Except that all of the litters were from gilts, and that the purebreds were Hampshires, a similar crossbreeding plan was followed at the Paulding County Experiment Farm. Eight comparisons of purebreds and crossbreds were made. At 180 days of age, the crossbred litters contained 0.7 of a pig more and averaged 203 pounds heavier per litter than the purebred litters.

The crossbred pigs were ready for market 20 days earlier, on the average, than were the purebred pigs.

Madison County Experiment Farm

The rotation plan of crossing with the same three breeds was also followed at the Madison County Experiment Farm, but there the purebreds were Poland Chinas. Eight comparisons were made. At 180 days of age, the crossbred litters contained 1.4 more pigs and averaged 292 pounds heavier per litter than the purebred litters.

The difference in the rapidity of the gains would have enabled the crossbred pigs to reach a weight of 220 pounds 9 days earlier, on the average, than the purebred pigs.

Ohio Agricultural Experiment Station

Studies of the efficiency of feed utilization as well as of the numbers of pigs farrowed and saved and of the rapidity of the gains of purebred and of crossbred pigs were made at the Ohio Agricultural Experiment Station.

Gilts approximately 1.0 year of age and sows approximately 1.5 years of age, respectively, had fewer still-born pigs and saved a larger percentage of the pigs farrowed alive than older sows.

Sows 1.5 to 3.5 years of age saved more pigs per litter and their litters were heavier at 8 weeks of age than were those of younger or older sows.

In the crossing tests at the Ohio Agricultural Experiment Station the purebred sows used were Durocs.

According to U. S. D. A. Technical Bulletin 836, differences in litter size exist between breeds. Possibly the data for some of the breeds were insufficient to be trustworthy but in size of litters farrowed they ranked the breeds as follows: Yorkshires, Durocs, Chester Whites, Hampshires, Poland Chinas, and Berkshires. Doubtless differences in prolificacy exist between strains or families within breeds as well as between breeds. If so, opportunities for improvement within a breed are provided.

In the order named, averages of 9.4, 7.9, and 8.0 live pigs were farrowed and averages of 6.9, 6.8, and 7.3 pigs were weaned per litter by gilts approximately a year of age, when (a) the pigs were purebreds, when (b) the pigs were crossbreds but out of purebred dams and, when (c) the pigs were crossbreds and were out of crossbred dams. All were by purebred sires. At 8 weeks of age, the three types of litters named averaged 193.5, 187.5, and 240.7 pounds in weight, respectively.

In the order named, averages of 10.6, 9.8, and 9.0 live pigs were farrowed and averages of 6.8, 6.8, and 6.4 pigs were weaned per litter by older sows, when (a) the pigs were purebreds, when (b) the pigs were crossbreds but out of purebred dams and, when (c) the pigs were crossbreds and were out of crossbred dams. All were by purebred sires. At 8 weeks of age, the three types of litters named averaged 229.8, 259.1, and 246.0 pounds in weight, respectively.

Crossbred Yorkshire × Duroc pigs from double-mated sows reached a weight of 220 pounds 11 days earlier than their purebred Duroc litter mates. Berkshire × Duroc pigs gained no faster and required as much feed per unit of gain as purebred Duroc pigs. Poland China × Duroc pigs gained faster, reached a market weight of 220 pounds 14 days earlier and required slightly less feed per unit of gain than purebred Duroc pigs. Size of the parent stock influenced the gaining ability of the pigs.

Weights of the National Swine Show prize winners from 1922 to 1933, inclusive, showed a tendency of breeds to vary in size. The breeds which were heavier at maturity were heavier also at the younger age classifications.

Pigs of a three-breed cross—that is by a purebred sire of one breed and out of crossbred dams of two other breeds—reached an average weight of 220 pounds 10 days earlier and required slightly less feed per unit of gain than purebred pigs.

Pigs of a two-breed backcross, which were by Duroc sires and out of Berkshire × Duroc dams, reached an average weight of 220 pounds 3 days earlier and required slightly less feed per unit of gain than purebred Duroc pigs.

Pigs of a three-breed backcross, which were by Duroc sires and out of dams whose sires were Berkshires and whose dams were Poland China × Durocs, reached an average weight of 220 pounds 13 days earlier and required 7.9 percent less feed per unit of gain than purebred Durocs. Since there were only a few three-breed backcross pigs in the feeding tests, whether their lower feed requirement per unit of gain was typical is not known. Their faster gains were in accord with those of the crossbreds subsequent to the second generation at the Miami County Experiment Farm. The faster gains of the latter would have enabled them to reach a weight of 220 pounds 13 days earlier than the purebred Durocs.

Although the data are not regarded as providing the final answer, they suggest that unless or until a better plan of breeding for the production of market hogs is developed, rotating purebred sires of three or more breeds on successive generations of sows selected from the herd is worthy of consideration.

Any merit crossbreeding has for the production of market hogs is the result of the pure breeding that has preceded it. For any improvements that are made and held in the inheritance of swine, the producers of crossbreds must depend on the breeders of purebreds and of inbred lines.

BIBLIOGRAPHY

1. Carroll, W. E., and E. Roberts. 1942. Crossbreeding in swine. Ill. Agr. Exp. Sta. Bull. 489.
2. Castle, E. C. 1940. Mammalian genetics: Harvard University Press.
3. Craft, W. A. 1943. Swine breeding research at the Regional Swine Breeding Laboratory. U. S. D. A. Misc. Pub. 523.
4. East, E. M., and D. F. Jones. 1919. Inbreeding and outbreeding; J. B. Lippincott Co.
5. Evans, B. R., and J. B. Beckett. 1945. Fifty six-day litter weight summary, 1938 though 1944, Duroc Production Registry. Duroc News, **19**: 30.
6. Lush, J. L., P. S. Shearer, and C. C. Culbertson. 1939. Crossbreeding hogs for pork production. Iowa Agr. Exp. Sta. Bull. 380.
7. ————, and A. E. Molln. 1942. Litter size and weight as permanent characteristics of sows. U. S. D. A. Tech. Bull. 836.
8. Smith, W. W. 1937. Pork production, p. 142; Macmillan Co.
9. Snyder, C. E. 1933. Average weights of National Swine Show winners, 1922-1933. Chicago Daily Drovers Journal.
10. Whatley, J. A., Jr., and E. L. Quaife. 1937. Adjusting weights of pigs to a standard age of 56 days. Am. Soc. Anim. Prod., Proc. 30: 126-130.
11. Winters, L. M., O. M. Kiser, P. S. Jordan, and W. H. Peters. 1935. A six years' study of crossbreeding swine. Minn. Agr. Exp. Sta. Bull. 320.
12. ————, ————, ————, and ————. 1936. Crossbred swine. Minn. Agr. Exp. Sta. Spec. Bull. 180.
13. Wright, S. 1920. Principles of livestock breeding. U. S. D. A. Bull. 905.
14. ————. 1922. The effects of inbreeding and crossbreeding on guinea pigs. 1. Decline in vigor. 2. Differentiation among inbred families. U. S. D. A. Bull. 1090.
15. ————. 1922. The effects of inbreeding and crossbreeding on guinea pigs. 3. Crosses between highly inbred families. U. S. D. A. Bull. 1121.

This page intentionally blank.